SAFETY ENGINEERING STUDY FOR A TYPICAL PALM OIL MILL

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SAFETY ENGINEERING STUDY FOR A TYPICAL PALM OIL MILL

By

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MATRIC NO. 3043

A project paper presented to the

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APPROVAL SHEET

This project paper attached hereto, entitled " **Safety Engineering Study For a Typical Palm Oil Mill**" prepared and submitted by **Siti Zahrah Hj. Sahari (3043)** in partial fulfillment of the requirements for the Degree in Bachelor of Engineering with Honours (Mechanical Engineering and Manufacturing System) is hereby accepted.

29th September, 2001

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ABSTRACT

SAFETY ENGINEERING STUDY FOR A TYPICAL PALM OIL MILL

by

Siti Zahrah Hj. Sahari (3043)

The objective of this report is to develop a system approach (termed Safety Engineering Study) to industrial accident prevention for a typical palm oil mill. Adoption method for the research was by carrying out study on the management of the two (2) selected palm oil mills in Sarawak, i.e. to probe the applicability, strengths and weaknesses of its organization safety policies and practices. Other tasks carried out included study on the process of palm oil mill and analyzing its risk, inspection on the operation, reviewing of work programmes, observing personnel working attitudes as well as inquiring on safety practices and training provided. This report managed to provide information on the operation of a typical palm oil mill, identifying the major causal factors of accident, drawing up the safety precautions as well as defining and developing preventive measures. Finally, a Palm Oil Mill Safety Analysis is developed to represent the overall result of study.

ABSTRAK

SAFETY ENGINEERING STUDY FOR A TYPICAL PALM OIL MILL

Oleh

Siti Zahrah Hj. Sahari (3043)

Kertas kerja ini bertujuan untuk menghasilkan satu pendekatan ke arah menangani masalah keselamatan di kilang pemprosesan minyak sawit. Kaedah yang digunakan untuk menjayakan kertas kerja ini ialah dengan menjalankan kajian ke atas pengurusan dua (2) buah kilang sawit di Sarawak, untuk mengkaji tahap keberkesanan sesebuah kilang itu terhadap aspek keselamatan yang dipraktikkan. Antara program kerja lain ialah menganalisa risiko pemprosesan dan membuat pemerhatian terhadap sikap kerja yang diamalkan. Kertas kerja ini juga mendedahkan pembaca terhadap kaedah pemprosesan minyak sawit, mengenalpasti faktor-faktor utama yang menyebabkan kemalangan, menghasilkan serta merangkaikan langkah-langkah pencegahan yang patut. Akhir sekali, kertas kerja ini dapat menghasilkan satu analisa kesclamatan untuk mewakili keseluruhan aspek keselamatan sesebuah kilang kelapa sawit.

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1.1 Palm Oil Industry

The palm oil industry in Malaysia has developed into a multi-billion industry as what is witnessed today. Its plantation begin to shape the country agriculture landscape in the 1960s as government moves towards diversification of agriculture commodities to broaden the economic base and due to the declining price of rubber. Now, Malaysia is recognized as the leading nation in oil palm plantation, being the world largest producer and exporter of palm oil[1]. It enjoys this competitive edge due to the continuous research and development programmes to chart new findings, which would, enhances its value.

Changes both evolutionary (incremental) and revolutionary (a significant step) are continuously looked for and implement to keep Malaysia at the forefront of the world's palm oil industry as well as to maintain the viability of its palm oil milling industry. With the growing number of palm oil mills in Malaysia (as per Table 1.1), milling technology does change, even though the overall palm oil extraction process has not change.

[1] As per reported by Malaysia Palm Oil Board (MPOB) , Palmoil Update August 2000

1.2 Palm Oil Processing

Fresh Fruit Bunch (FFB) transported from the estates will be unloaded from lorries onto the ramp at the reception station. The reception station consists of an inclined steel ramp (at 20° to 27°) with concrete yard. From the loading ramp, the FFB will be then be unloaded into fruit cages through the discharge door mechanized hydraulically, pulled by wire-rope capstan along the rail track and charged into the sterilizer. This is where the first treatment of the bunches is subjected to.

Table 1.1: Latest number of Palm Oil Mills in Malaysia

Number of Palm Oil Mills in Malaysia			
State	**No.**	**State**	**No.**
Kedah	3	Johore	72
Penang	3	Pahang	68
Perak	43	Terengganu	12
Selangor	26	Kelantan	9
Negeri Sembilan	14	Sabah	86
Malacca	2	Sarawak	17
Total No. Of Palm Oil Mills			**355**

Source: Porla Statistics (April 2001)

The functions of the sterilizer station are to inactivate enzymes which hydrolyze the oil and loosen fruitlets from the bunch as well as softening the fruit pulp for easier digestion of the fruit. The sterilizers are normally of the horizontal single-sided door, with built-in distribution plate (so steam can be evenly distributed) and a pair on internal rail to hold the wheels of the cages. They can accommodate about eight cages of 2.5 MT capacities. The FFB will be "cooked" under saturated

steam and the sterilising technique usually adopted is the three (3) peaks sterilization at 35 to 40 psi for 80 to 90 minutes.

After sterilization, the fruit cage is then lifted by the overhead hoist crane and emptied into the thresher hopper. The thresher hopper can hold as much as two (2) cages of FFB at one time. The bunches will then slide into the hopper – an inclination of not less than 30°. The bunches are fed into the thresher drum by spike retarders (auto feeder) which rotate at a controlled speed usually 2 to 3 rpm. The thresher drum (capacity to hold about 30 MT) is of the horizontal rotating drum type. The rotation of the drum subjected the bunches to centrifugal force and when it touches the drum, it rolls upward and at a height just above the vertical centre line of the drum, the bunches fall off to hit the lower portions of the rotating drum. The impact causes the fruitlets to be knocked off the bunches. This is repeated as the bunches are pushed forward to the exit end of the drum by the combined action of fresh incoming bunches and by the lifters bars (angled to the longitudinal axis of the drum) which throws the bunch forward.

The screw conveyor then collect the loosefruit including some thrash and discharge them into the conveying or elevating system. The empty bunch will then goes to the conveyor and the elevator into the incinerator or bunch hopper. The fruitlets will then flow into the digester. This digester is situated in the pressing station. It is of the vertical type, steam jacketed vessel with live steam injection point, installed with 5 stirring arms and an expeller arm. Built inside the digester are also baffle plate and lining. The loosefruit is fed into this digester where the digester is kept full or at least ¾ at all time to allow sufficient retention time for the mass passing digester (MPD) to be digested and to obtain maximum stirring effect up to the top pair

of the stirring arms. Basically the function of this station is to extract palm oil from the mesocarp of the fruit by means of a digester, to break plant cells for easier release during pressing and screw press, i.e. to extract oil from the pericarp fibre by pressing. The digester mash should be drained off the oil before it is fed into the press to enhance pressing efficiency. The main screws of the screw press are arranged side by side where the MPD are fed directly from the digester via a feeding chute. The presscake will then move into the Cake Breaker Conveyor (CBC).

The crude oil from the screw press will pass through vibrating screens. This is where the solids are removed from the crude oil. The vibrating screens are doubled-decked and fitted with tightly stretched stainless steel screen of 20 and 40 mesh size, generated by a rotating eccentric shaft mounted on roller bearings on the frame of the screens. Screening is assisted by hot water jet sprayed to the incoming crude oil.

At the depericarper station, the presscake from the CBC will be subjected to nuts (for kernel recovery) and fibre (as boiler fuel) separation after the oil extraction. The nuts are cleaned of the remaining strand of fibre sticking to the nut. Fibre is pneumatically blown to the boiler house. The depericarper pneumatic system has been designed and set with sufficient velocity and draught to only lift and convey fibre with the airflow but the nuts drop and convey to the drum. Rotary drum is installed with series of baffle plate to polish nuts off the fibrous threads.

The nuts from the depericarper station will be subjected to nut cracking, usually by the ripple mills at the kernel recovery station to extract their oil-bearing kernels. The nuts bounce between the revolving rotors bar assembly and the stationary ripple plate of the ripple mills for cracking and deshelling. The cracked nuts will then be flowed into the Kaolin claybath separator to separate the shell and kernel. The

method is to maintain the specific gravity to within 1.16 to 1.2 so kernel could rise to the surface, flow gradually with the Kaolin solution to the kernel discharge end. Shell will sink to the bottom of the conical tank and flow to the shell side of the vibrating screen. Silos are used to retain kernels, kept at 60°C for 6 to 8 hrs retention time.

For the crude oil which has passed through the vibrating screens, will now go through the clarification station where the pure crude oil will be separated from the crude oil as well as the solid impurities and dissolved moisture content. The clarification station is of the vertical continuous tank system and equipped with centrifuges as well as sludge separator (separates the sludge from the crude oil) and purifiers. In this station, vacuum drying equipment is also used to remove the final traces of moisture from the purified oil before pumping into the CPO tank, ready to be dispatched. Sludge will enter the sludge pit and recycled.

The schematic flow diagram of the process is shown in Figure 1.1. The palm oil milling until today is still a very mechanical process. It has resisted putting in the electronics to make it looked sophisticated or elegant. Partly because the equipment used and the materials handled do not lend themselves easily to an automated process and partly because the economics of putting these in still does not really work out. It was observed there had been a fair bit of changes in the milling machinery and process technique. If we are to talk about the new design concepts of milling technology, the list could go on.

But this paper does not sought to explain the central ideas of the process flow in which the FFB is subjected to once it gets to the mill, from the fruit reception station (as what they are practically called) to the dispatch product or the new technology involved.

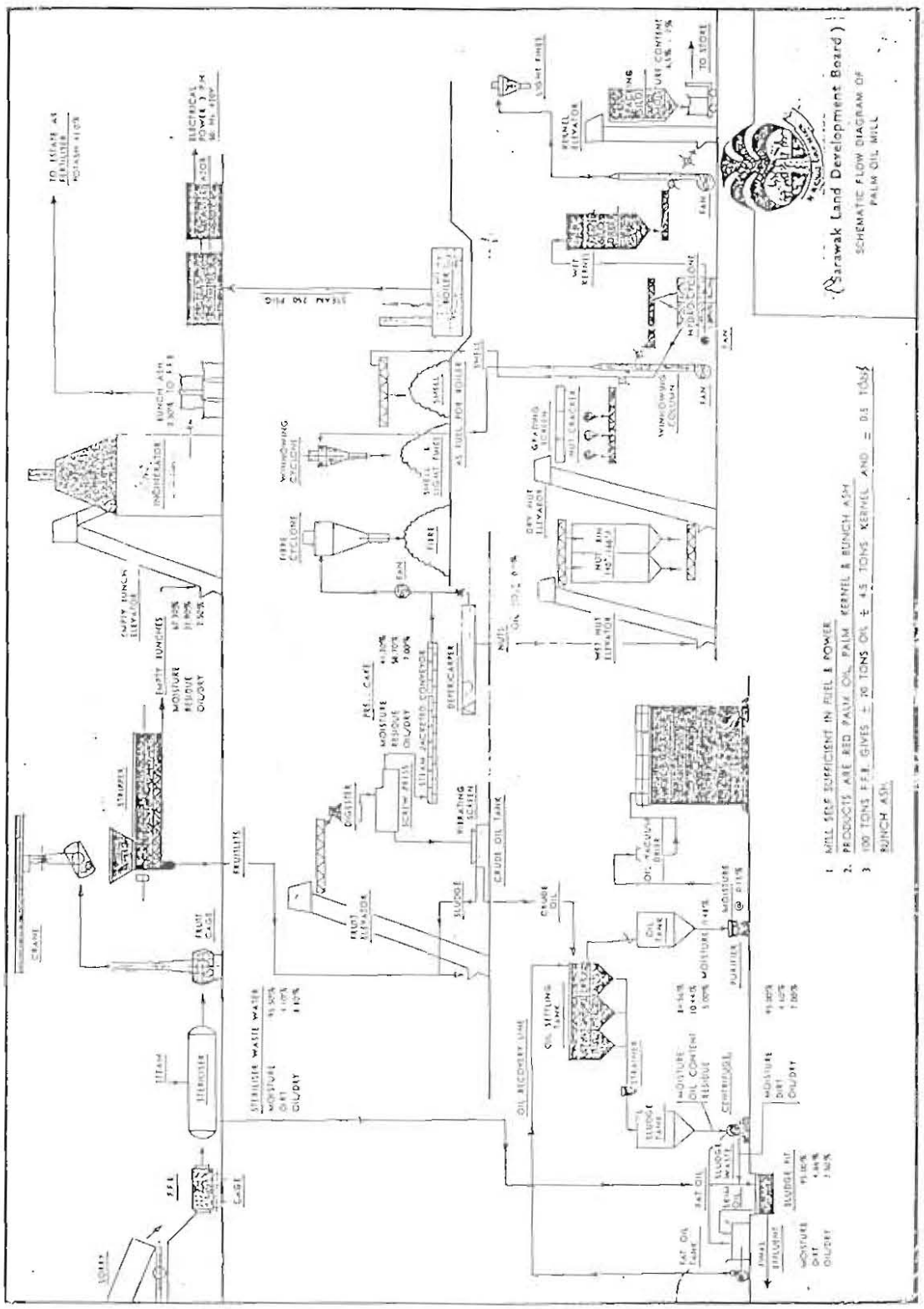

Figure 1.1: Schematic Flow Diagram of a Palm Oil Mill Process

This paper meant to cover one thing which should not be treated separately from the design, production or maintenance of a milling technology, which is the safety aspect in the process industry. Safety is inextricably interwoven into these and other activities involved. It depends on both the technical competence and safety awareness of all staff and employees. Pursuit of safety is largely a matter of identifying hazards, eliminating them where possible or otherwise protecting against their consequences. Lesson learnt from the past is that the capacities of process plants and the magnitude of major losses involving them have increased continuously and are still increasing.

It may seem presumptuous to cover all the hazards of palm oil milling industry with their many different technologies. Yet when considering the causes of part accidents, most appear to be well within the understanding of anyone with a broad technical background.

1.3 Objective of this Report

As mentioned earlier, this report implies to cover the overview of the industrial safety practiced in a palm oil milling industry. Where appropriate, this report will identify the major contributors to the risks from accidents (high-risk areas) that threatens the safety and health of the employees and/or the general public, cause the loss of production and/or capital equipment, to draw-up the safety precautions to be taken or to be aware of, as well as to define or develop any preventive measures where appropriate at every stations. Basically, the mission statement of this report is to ***develop a system approach (termed Safety Engineering Study) to industrial***

accident prevention for a typical palm oil milling industry in Sarawak. Though, maybe by coincidences, certain coverage may apply to other palm oil mills in Malaysia.

1.4 Rational/Justification of this Report

Safety references are abounded but not specified. Meaning to say, even though there are lots of books, journals, articles on industrial safety can be found on shelves, no particular one has been specifically on palm oil milling industry. Sure, not many accidents had occurred in this industry for the last ten years, but it can never be assumed that things will be the way it has been. Furthermore, how few the accidents that occurred in this industry, it does affect the overall statistics as per Table 1.2 below.

Table 1.2: Statistic on Total Number of Industrial Accident in Malaysia

Year	Reported	Death
1995	114137	828
1996	106508	1020
1997	86589	1473
1998	85338	1273
1999	92074	984
2000 (up to June)	36854	357

Source: Social Security Organisation (SOCSO)

For 1999 alone, Manufacturing and Processing sectors contributed to 44.25% of the overall number of industrial accident in Malaysia. Table 1.3 shows the latest statistic available on the total number of industrial accident according to industrial sectors in Malaysia as per year 1999.

The report does not act to be a safety handbook or a solution for all safety matters in a typical palm oil mill, its approach is more to the possibilities of accidents that tend to increase, not only in types but also in magnitude. The causes and effect of accidents and precautionary measures that can be taken for their prevention and avoidances will also be included. Afterall, the increase in public apprehension has not loosened the desire for safety. ***The increase has been in the desire to know why accidents happen and how to prevent it from happening.***

Table 1.3: Statistic on Total Number of Industrial Accident According to Industrial Sector – 1999

Sectors	Number of Reported Accidents
a) Agriculture, Forestry and Fishing	12753
b) Mining and Quarrying	756
c) Manufacturing and Processing	40730
d) Construction	4747
e) Electricity, Gas, Water & Sanitary Services	592
f) Commerce	14685
g) Transport, Storage & Communication	4462
h) Financial Institution and Insurance	627
i) Services	5987
j) Civil Services	6735
Total No. of Accidents	**92074**

Source: Social Security Organisation (SOCSO)

Needless to say, most human activities carry special risks and safety is a manageable activity, cannot be defined as something which is completely random, without recognizable cause or is a dependent upon the act of GOD. Safety requires identification and control of causal agents, in order to provide value to organizations.

Its safety value is the conservation of limited personnel and other resources. If this is done with great leverage (in terms of use of resources), and if it is done optimally within system constraints, safety is successful in contributing to the bottom line. It must be emphasized that the best application of safety is early in system development, rather than after the fact.

The following features are characteristics of the palm oil milling industry:

1) Large scale of operations with capacity of processing from 20MT/hr to 60MT/hr.
2) Continuous operation, with long runs, more than one (1) line operating at a time and shifts working.
3) Each equipment or machine is designed for a specific process.
4) Mechanical handling of process materials.
5) Use of process temperature and pressure above or below ambient such as the use of pressurized vessels.
6) Total enclosure of process materials within pipes and equipment.
7) Use of liquid and gaseous process materials.
8) Requiring consistent maintenance of machinery to avoid downtime.
9) Inspection, installation and supervision of certain process equipment or machines requiring skilled/trained personnel.
10) Production of Crude Palm Oil (CPO) and Palm Kernel (PK).

With characteristics as above, surely safety is of much concern and should not be taken lightly or for granted.

1.5 Definition of Terms Used in this Report

As per defined by Internet Encarta Encyclopedia:

Industrial Safety Area of safety engineering and public health that deals with the protection of workers' health through control of the whole environment to reduce and eliminate hazards.

As defined by Webster's Unabridged Dictionary:

Safety The condition of being safe: freedom from exposure to danger; freed from harm, injury or risk: no longer being threatened by danger or injury; the quality or state of not presenting risks; knowledge or skill in methods of avoiding accident or disease; freedom from danger.

Accident An unplanned interruption of planned business activity, resulting in loss.

Loss Degradation of a system or component.

Risk The result of loss-probability occurrence and the acceptability of that loss.

Hazard The condition with the potential of causing injury or damage.

1.6 Limitations of this Report

This report only covers palm oil milling industry, not plantation or refinery activities which also contribute to the economics of palm oil industry as a whole in Malaysia. Study was only carried out on two (2) palm oil mills in Sarawak (Mukah Palm Oil Mill and Niah Palm Oil Mill) and should not be taken as a representative of the palm oil milling industry throughout Malaysia.

Since it covers a broad and complicated subject, compromises have been made to keep the information to a reasonable size, while attempting to emphasize the important points.

This report does not attempt to cover hazards of chemical because not much chemical substances are used in palm oil mill processing. Legal and compensation aspects of safety have also been omitted due to lack of competency in those areas.

Chapter 2 Safety Standards and Practices

Common belief is that "Safety is a common sense". But accidents keep on happening over and over again. Why is this so? Human being tends to be momentarily forgetful, careless and reckless. Therefore, specific regulations regarding safety is needed to spell out certain minimum requirements such as installation of guards, used of protective equipment, and safe working procedures. To ensure these compliance, there is a penalty.

2.1 Industrial Safety Practices

Following are the applied main acts that concerned with the health and safety of the working population of the palm oil milling industry and those who may be put at risk from the manner in which the work is being carried out are:

1) The Factories and Machinery Act, 1967

   The Factories and Machinery (Notification, Certification of Fitness and Inspection) Regulations, 1970 Regulation 10(2) Part III Inspection. (Refer to Form A, B and C Sixth Schedule for Certificate of Fitness Steam Boiler, Unfired Pressure Vessel and Hoisting Machine in Appendix A1, A2 and A3 respectively)